

$$\Gamma = \begin{matrix} \text{unborn} \\ \text{alive} \\ \text{dead} \end{matrix} \begin{matrix} u & a & d \\ \begin{bmatrix} 1-\beta & \beta & 0 \\ 0 & \phi & 1-\phi \\ 0 & 0 & 1 \end{bmatrix} \end{matrix}$$

$$P = \begin{bmatrix} 1-\delta & 0 & 0 \\ 0 & \boxed{P_a} & 0 \\ 0 & 0 & 1-\delta \end{bmatrix}$$

$$\prod_{i=1}^N P(\underline{w}_i)$$

Spatial
crypt hist

\underline{w}_t

$P(\underline{w}_t | \delta_t)$

\underline{w}_1

\underline{w}_2

\underline{w}_T

$\delta_t = \text{observed?}$

δ_1

δ_2

δ_T

$P(\delta_t | s_t)$

State $\in \{u, a, d\}$:

s_1

s_2

s_T

occasion $t=1$

2

T

$$P(\text{unseen}) = P(\text{unseen, alive}) + P(\text{unseen, unborn})$$

Poisson ($\lambda(d_{ij})$)

$$P(\underline{w}_{it} | \delta_{it}=1) = \prod_{j=1}^J \frac{P(n_{ij} | x_i)}{1 - \prod_{j \in \underline{w}_{it}} P(n_{jx}=0 | x_i)} = \frac{\prod_j P(n_{ij} | x_i)}{P(x_i)}$$

$$\boxed{P_a} = P(\delta | s_t = a, x) = P(x) (1 - P(x))^{1-\delta}$$

$$P(\delta=0 | s_t \in \{u, d\}) = 1$$